

I²C settings for APV operation at cold temperatures – measurements on a TEC module

Mark Raymond – April, 2005

1. Introduction

This note gives recommendations for optimum APV bias register I²C settings for TEC modules, resulting from studies on a 4 APV TEC module (type 2.11.25.22(EC_R6P.4U)). Details of the measuring technique will not be repeated here, since the method used was essentially identical to that used for TIB and TOB module studies [1,4]. An explanation of the origins of the power consumption dependence on temperature can also be found in [1]. The TIB results and some additional information can also be found in Powerpoint form [2].

Recommended values for CMS operation at -10° C

Table 1 lists recommended APV25 I²C bias current settings for a range of TEC hybrid temperatures. The performance and power consumption dependence on I²C bias register settings is sufficiently weak that a single set of parameters can be used to cover a reasonable temperature span, at least $\pm 5^\circ$ and probably more. The values for the -10° column in table 1 are recommended for CMS operation, and are identical (as expected) to those previously specified for the TIB [1] and TOB [4].

Cautionary note

While values for VPSP, ISHA and VFS are listed in table 1, these parameters should be considered as variables. VPSP sets the analogue baseline level and should always be ‘tuned’ to position this appropriately. The values for the pulse shape tuning parameters ISHA and VFS listed in table 1 were found appropriate for the particular APV on the TEC module used for this test.

2. Details of results and discussion

Table 1 summarises the results of the measurements on the 4 APV25 chip TEC module. The measurements are taken from the APV chip designated #5 in figure 1. The hybrid surface temperature was monitored in the centre between the two pairs of APVs.

The method used was identical to that used for the previous TIB module study [1]. The standard parameters were used at +30° and the I²C bias current parameters were adjusted to achieve a similar module power consumption at the lower temperature settings. This was done before the pulse shape was tuned. Since a lower value of ISHA (the shaper bias current) was required at lower temperatures, the final measured values for module power (after pulse shape tuning) show a small decrease in module power with decreasing temperature. The total module power measurements are similar, though slightly higher, to those measured for the TIB and TOB modules, but within the expected $\pm 10\%$ estimated tolerance [3]. The module power consumption figures will be dominated by the APVs, but also include APVMUX, PLL and DCU chip contributions.

The I²C bias current settings chosen for +20°, +10° and 0° are similar, but not identical, to those found appropriate for the TIB and TOB modules [1,4], but in practice the same values could have been chosen without significantly affecting the results. The -10° values are identical to those for the

TIB and TOB modules, allowing a standard identical set of parameters to be specified for TIB, TOB and TEC modules at the CMS operating temperature.

2.1. ISHA, VFS and VPSP

The values for ISHA and VFS in table 1 are those chosen to achieve a peak mode pulse shape close to the ideal, as can be seen in figure 2. The pulse shapes were acquired by averaging the internal calibration response for one group of 16 channels. The deconvolution response corresponding to the same tuned parameters is also shown. **Note that the optimum choices of ISHA and VFS depend on sensor capacitance and that the values here are for one chip on a particular TEC module.** For other module types different values will be required, and there will likely be some module to module and chip to chip variation within module types.

For these studies the movement in the analogue baseline with temperature was found to be relatively small. The value of VPSP was chosen to position the baseline at approximately 25% of the digital header range. The APV power consumption does depend on the position of the analogue baseline, see [1]

2.2. Pulse height spectra

The peak and deconvolution mode pulse height spectra in figures 3 and 4, obtained using a beta source, show gain and signal/noise increases with reducing temperature, similar to those observed for TIB and TOB modules [1,4].

3. Conclusions

Table 1 lists recommended values for TEC module operation in the +30° to -20° temperature range, and the values for -10 ° are those recommended for initial operation in CMS. The results are very similar to those for the previous TIB and TOB modules studied, and the -10° values are identical.

The results presented here are for one chip on a TEC module, for which appropriate values for the ISHA, VFS and VPSP parameters were chosen. Some chip to chip and module to module variation in the optimum values for these parameters is to be expected, and significant differences between different module types (different sensor dimensions and hence capacitance) are to be expected.

4. References

- [1] http://www.hep.ph.ic.ac.uk/~dmray/pdf/cold_APV_params.pdf
- [2] <http://www.hep.ph.ic.ac.uk/~dmray/ppt/APVcold.ppt>
- [3] [http://www.hep.ph.ic.ac.uk/~dmray/pdf/APV25 Power Consumption.pdf](http://www.hep.ph.ic.ac.uk/~dmray/pdf/APV25_Power_Consumption.pdf)
- [4] http://www.hep.ph.ic.ac.uk/~dmray/pdf/TOB_cold_APV_params.pdf

Table 1. Recommended APV25 bias parameter values (decimal) for TEC module operation at different hybrid temperatures. The values for the -10° column are those recommended for CMS operation.

* Note that values for VPSP, ISHA and VFS have been chosen for the particular APV on the **TEC** module studied. The optimum values for these parameters will vary from chip to chip and also depend on module type. See text for further discussion.

	Hybrid Temperature °C ($\pm \sim 2^\circ$)					
	+ 30°	+ 20°	+10°	0°	-10°	-20°
IPRE	98	94	92	89	85	85
IPCASC	52	50	49	47	45	45
IPSF	34	33	32	31	30	30
ISSF	34	33	32	31	30	30
IPSP	55	53	52	50	48	48
IMUXIN	34	33	32	31	30	30
VFP	30	30	30	30	30	30
VPSP*	37*	38*	39*	37*	37*	35*
ISHA *	65*	65*	65*	50*	50*	45*
VFS*	50*	50*	60*	60*	60*	60*
relative test pulse amp. for ICAL = 60 (normalised to + 30° value)	1.00	1.05	1.12	1.16	1.21	1.24
I125 [mA/module]	235	231	233	231	226	223
I250 total [mA/module]	540	543	537	536	537	540
I250 (analog bias OFF) [mA/module]	302	-	-	-	-	-
power [mW/module]	1643	1631	1633	1629	1625	1629

Figure 1. Diagram of module showing Peltier cooling and Pt100 temperature measuring points.

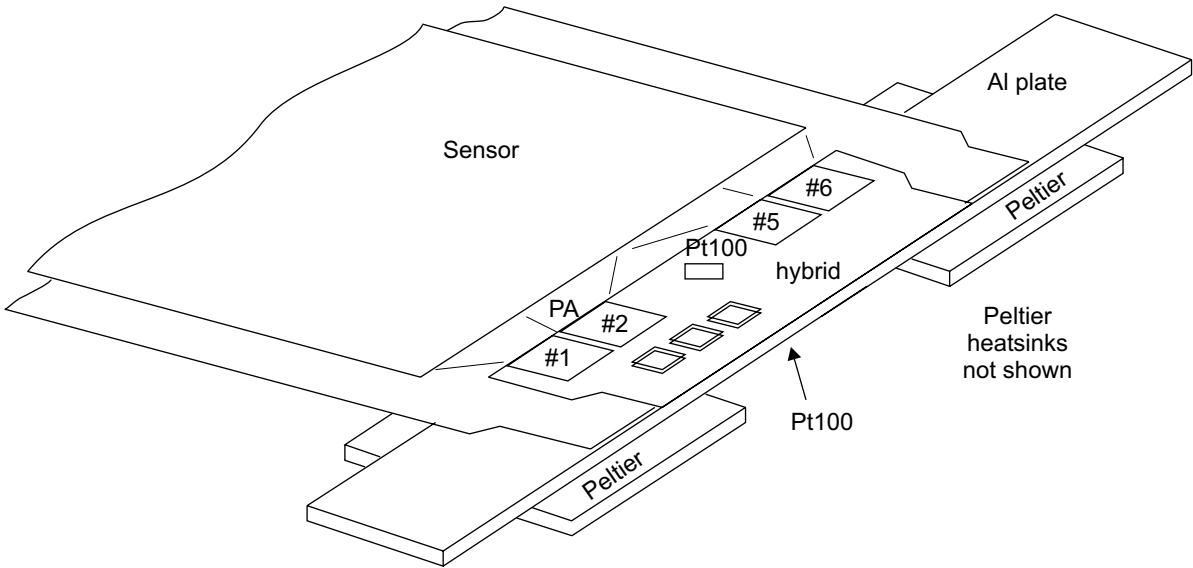


Figure 2. TEC module peak and deconvolution mode pulse shapes obtained after tuning the ISHA and VFS parameters at different hybrid temperatures. The pulse shapes shown are the average of 16 channels corresponding to one calibrate input. ICAL = 60 in all cases. Measured peak mode pulse shape is shown in red, ideal 50 ns CR-RC pulse shape in green, deconvolution mode pulse shape in blue.

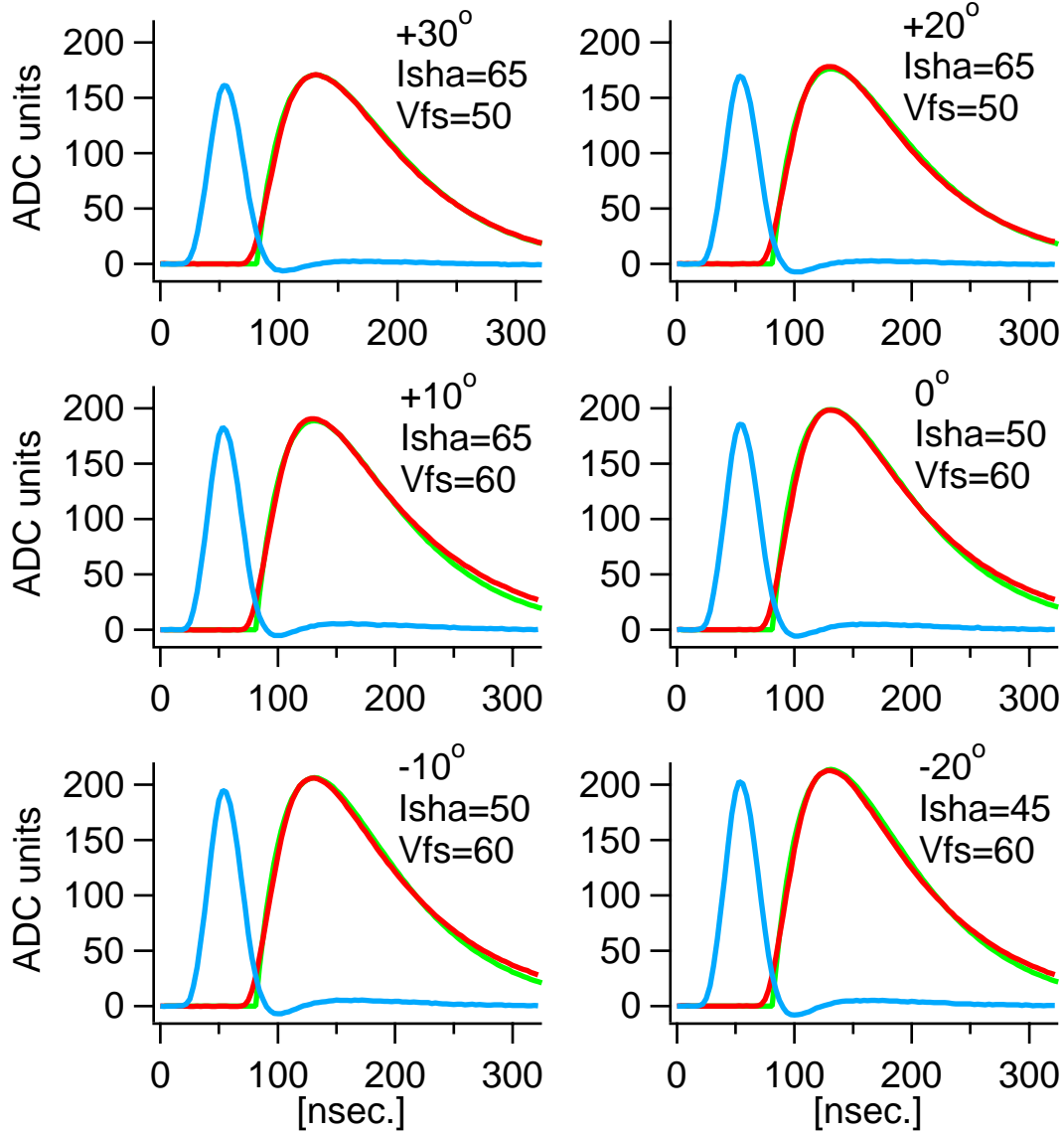


Figure 3. TEC module peak mode beta source pulse height spectra for different module temperatures. Strip signal included if neighbouring strip signals $< 3 \times$ noise. Sensor HT = 250 V.

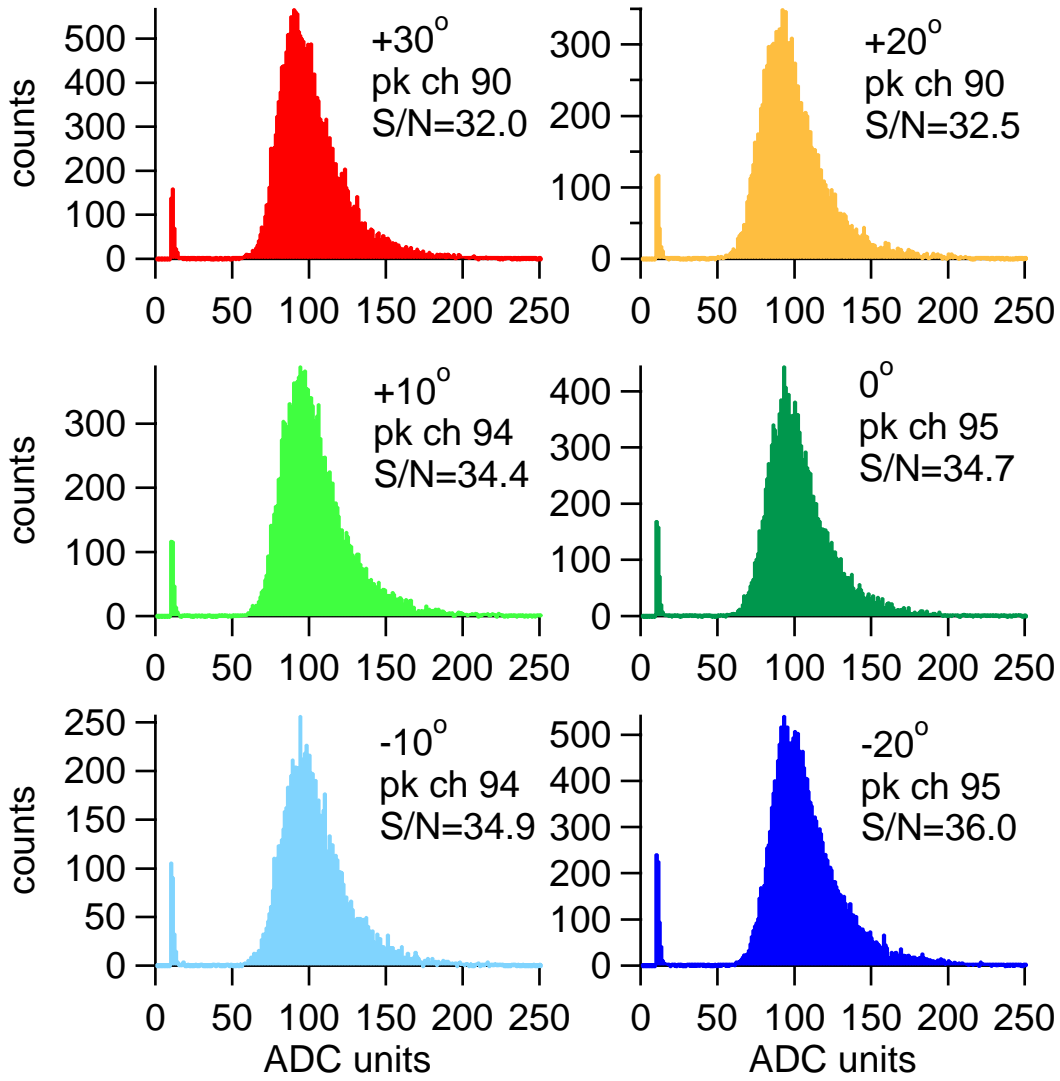


Figure 4. TEC module deconvolution mode beta source pulse height spectra for different module temperatures. Strip signal included if neighbouring strip signals $< 3 \times$ noise. Sensor HT = 250 V.

